

Code of Management Practice

Guide for Diagnostic and Industrial X-Ray Film Processors



Recommendations on Technology,
Equipment and Management Practices for
Controlling Silver Discharges from
Facilities that Process Photographic Materials

The Silver Council

The Code of Management Practice Guide for Diagnostic and Industrial X-Ray Film Processors

This Guide has been written for hospitals, dental offices, chiropractic clinics, veterinary clinics and industrial X-ray film processing (i.e., nondestructive testing) facilities. It contains a set of recommended operating procedures designed to reduce the amount of silver in film processing solutions AND the overall volume of solution discharged to the drain.

If your municipality **has** adopted the Code of Management Practice for Silver Dischargers, use this Guide to help you implement the requirements of the Code.

If your municipality **has not** adopted the Code of Management Practice for Silver Dischargers, use this Guide to help you establish an effective silver recovery or silver management program.

Limitations

The Code of Management Practice Guide for Diagnostic and Industrial X-Ray Film Processors **does not** supercede existing local regulations. Where the Code **has not** been adopted, relying exclusively on this Guide may cause diagnostic and industrial X-ray film processors to be out of compliance with local regulations. Therefore, before using this Guide, each diagnostic and industrial X-ray film processor should check with the local government agency to determine its regulatory requirements. For more information contact The Silver Council.

The Silver Council

The Silver Council is a national group focused on the environmentally sound management of silver derived from the processing of photographic images. The Silver Council is supported by the photographic chemical and equipment manufacturers and associations and represents more than 360,000 users. The purpose of the group is to encourage communications between the regulatory and regulated communities, to support scientific research, and to share current scientific, technical and economic information about silver so that the common goals of pollution prevention, recycling, water conservation, and compliance can be met.

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The participants volunteered their time and expertise, thus ensuring this guide provides an approach written for diagnostic and industrial X-ray film processors. Our thanks to each of these people and their companies. Special thanks go to The Silver Council for funding this project.

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Table of Contents

1.0 Introduction	1
1.1 Regulating Silver	2
a. Concentration-based Limits	2
b. Performance-based Limits	2
What's the Concern With Silver?	3
1.2 Implementing the Code	4
2.0 Determining the Category	5
Chart - Size Category Based on Type and Quantity of Film Processed Daily	5
3.0 Small Processors	6
3.1 Options	6
3.2 Equipment Configurations	6
1. One or Two Metallic Replacement Cartridges	7
2. Off-Site Management	8
4.0 Medium Processors	9
4.1 Options	9
4.2 Equipment Configurations	9
1. Terminal Electrolytic Unit Followed by a Metallic Replacement Cartridge	10
2. In-line Electrolytic Unit with a Metallic Replacement Cartridge	11
3. Two or More Metallic Replacement Cartridges	12
4. Off-Site Management	13
5.0 Large Processors	14
5.1 Options	14
5.2 Equipment Configurations	14
1. Terminal Electrolytic Unit Followed by Two or More Metallic Replacement Cartridges	15
2. In-line Electrolytic Unit with Two Metallic Replacement Cartridges	16
3. Off-Site Management	17

Table of Contents

6.0	Pollution Prevention	18
6.1	Create a Team	19
a.	Management Activities	19
b.	Staff Activities	20
	Pollution Prevention Team Checklist	21
6.2	Review Your Options	22
a.	Management Practices	22
	Preventive Maintenance	22
	Process Control	22
	Inventory Control	22
	Spill Response Planning	22
	Good Housekeeping	24
	Safety and Security	24
	Management Practices Checklist	25
b.	Equipment Modifications	27
	Crossovers/Squeegees	27
	In-line Silver Recovery	27
	Standby Water Saver	27
	Equipment Modifications Checklist	28
c.	Process Modifications	29
	Solution Regeneration and Reuse	29
	Water Recirculation and Recycling	29
	Dry Chemicals and Automated Mixing	29
	Process Modifications Checklist	30
d.	Solid Waste	31
	Solid Waste Checklist	32
6.3	Develop a P2 Plan	33
	Screening Your Options	33
	Worksheet for Screening Options	33
	Point System	34
	Writing the P2 Plan	34
	Pollution Prevention Plan Worksheet	34
6.4	Put the Plan in Place	35
6.5	Track Your Results	35
	Worksheet for Evaluating P2	35
	Spread the Word	36

Table of Contents

Appendices

Appendix A	Glossary of Terms	37
Appendix B	Electrolytic Silver Recovery	40
Appendix C	Metallic Replacement	43
Appendix D	Off-Site Management	46
Appendix E	Ion Exchange	49
Appendix F	Testing for Silver	51
Appendix G	Forms	53
	Sample Spill Contingency Plan	54
	Worksheet for Screening Options	55
	Pollution Prevention Plan Worksheet	56
	Worksheet for Evaluating P2	57
Appendix H	Assumptions for Size Category	58

1.0 Introduction

Liquid effluent is a by-product of processing diagnostic and industrial X-ray films. After silver recovery, this effluent is generally discharged to the drain where it goes to the publicly owned treatment works (POTW) for treatment, and eventual release back to the environment.

Silver is the component of film that makes it possible to form an image. During processing the silver is removed from the film and goes into the fixer. While a small amount of silver may be carried over into the wash water, fixer is the only silver-rich solution produced in a diagnostic and industrial X-ray processing facility. Silver should be recovered from silver-rich solutions before they are discharged to the drain because:

- silver is a non-renewable resource,
- some cities/towns restrict the amount of silver that can be discharged, and
- silver has economic value.

A silver-rich solution is a solution that contains sufficient silver that cost-effective recovery can be done either on-site or off-site. For purposes of this guide, fixer is the only silver-rich solution produced from processing films.*

Effective silver recovery requires equipment that is appropriate to the size and activities of the diagnostic or industrial X-ray film processor. It also requires implementing a

sound preventive maintenance program. Providing you with this silver recovery information is the primary focus of the Code of Management Practice Guide for Diagnostic and Industrial X-Ray Film Processors.

The principle element of the Code of Management Practice Guide for Diagnostic and Industrial X-Ray Film Processors is a set of recommended operating procedures designed to reduce the amount of silver in film processing solutions AND the overall volume of solution discharged to the drain.

The other element of the guide is **voluntary** pollution prevention. In addition to recovering silver efficiently, diagnostic and industrial X-ray film processors should be concerned with minimizing the amount of waste they create. Waste solutions are literally money down the drain. In cases where the solutions can't be discharged to the drain, such as when the processor discharges to a septic system, it costs money for off-site disposal. That's why it makes sense to minimize waste in the first place. The second half of the guide details several activities a diagnostic or industrial X-ray film processor can **voluntarily** undertake to reduce waste and save money.

The Code of Management Practice Guide for Diagnostic and Industrial X-Ray Film Processors is an industry-recommended guide. It is **NOT** a legal requirement. It was written by people just like yourselves

* The Code of Management Practice addresses silver from film processing solutions only.

— people who manage diagnostic or industrial X-ray film processing operations. The guide takes the guesswork out of determining the specific silver recovery equipment configurations and preventive maintenance activities you need. Terms used throughout this guide are defined in the Glossary of Terms (Appendix A).

1.1 Regulating Silver

Regulatory agencies can control the discharge of silver to the drain in two ways:

1. by using *concentration-based* limits and regulating the concentration or total amount of silver allowed in wastewater, or
2. by using *performance-based* limits and requiring that suitable treatment be applied before the wastewater is discharged.

a. Concentration-based limits

The traditional means of restricting silver is through **concentration-based numerical limits** in the city sewer ordinance. For example, silver may be restricted to four parts per million (4 ppm).^{*} This means that for every million parts of effluent[†] there can be **no more** than four parts of silver.

Concentration-based limits have been shown to be a poor way to regulate diagnostic and industrial X-ray film processors for several reasons:

^{*} ppm is the same measurement as milligrams per liter (mg/L).

[†] Effluent means the liquid waste generated from the processing of film.

1. Our industry conserves water through standby water savers and lower replenishment chemicals. As we use less water, the concentration of silver in the effluent increases. Concentration-based limits, therefore, actually penalize those who practice water conservation.
2. Municipal and state sewage treatment authorities ideally develop pretreatment limitations by comparing wastewater coming into the sewage treatment plant and the treated water leaving the plant. The discharge of treated wastewater must meet limits set by the state to avoid impacting the water quality of the receiving body of water. Local development of pretreatment limitations has resulted in widely varied and often unrealistic restrictions across the country.
3. The sampling point used to determine whether or not a limit is being met is determined by the local sewer authority. It may be the property line manhole or a point where all process wastewater is combined. This introduces additional variation from city to city.
4. Industry's ability to recover silver cost-effectively is dependent upon the equipment available in the marketplace. Restrictions in some jurisdictions are so stringent they can not be met with the best available technology that is economically achievable.



b. Performance-based limits

Performance-based limits are spelled out as a percentage of the silver that must be

recovered from discharged solutions.

These limits provide environmental protection while taking into consideration the amount of silver-rich solutions generated by diagnostic and industrial X-ray film processors, the efficiency of the best available technology (equipment), and the capabilities of the generating facility.

The Code of Management Practice places diagnostic and industrial X-ray film processors into one of four categories and provides specific silver recovery equipment recommendations for each category. The category may vary for each film processing machine in your facility. For example, in a large hospital, there may be a small machine that runs only five films per day. This machine would fall into the small category. In the same hospital, there may be a very busy machine that runs 150 films per day and would, therefore, fall into the medium category.

If the POTW were categorizing your facility, it might take into consideration all the process effluent produced per day in the *entire* facility. For our purposes that's not very helpful. It could easily result in requiring an extensive silver recovery system on every film processing machine — even one on which only a few films per day are processed. If you have this type of situation in your facility, you may need to negotiate with your POTW when it comes to categorizing your equipment.

The exception is in facilities where silver recovery operations are centralized. In these cases, where the fixer from many processors is collected and desilvered in a central location, the category is based on the total volume of fixer and processing effluent produced at the centralized treatment site.

What's the Concern With Silver?

We wear silver jewelry, eat off silverware and carry silver fillings in our teeth. Then why is the silver in film processing solutions regulated? The answer has to do with the different forms silver can take. The metallic silver that we use in eating utensils and jewelry is nontoxic. But some forms of silver can be very toxic to aquatic organisms. In fact, years ago, silver cation (Ag^+) was used as a biocide in wastewater treatment. Even today, silver nitrate is sometimes added to the eyes of new infants in order to kill bacteria.

Because the silver ion is highly reactive, it quickly and easily complexes with materials in the environment such as sulfides and chlorides, to yield compounds with little or no toxicity. This means that silver rarely occurs in ionic or noncomplexed forms. The silver found in used film processing fixer, for example, is in the form of silver thiosulfate, a nontoxic form.

While there is general agreement among regulators that it's the ionic form of silver that's most toxic, there's no accurate and repeatable analytical test method to measure the ionic species. Therefore, regulations are based on total silver, with no differentiation made between ionic and complexed forms of silver.

Silver discharge regulations impact all film processors from the small dental office to the large diagnostic imaging clinic to the industrial X-ray film processor. While individual dischargers may have little impact on the POTW, collectively, diagnostic and industrial X-ray film processors discharge a significant amount of silver.

The four categories of film processors identified in the Code of Practice, are as follows:

- A **small** diagnostic or industrial X-ray film processor is one that produces *less than* two gallons per day of silver-rich solutions and *no more than* 1,000 gallons per day of total process effluent. Small processors should recover silver to at least 90 percent efficiency. 90%
- A **medium** diagnostic or industrial X-ray film processor is one that produces *less than* 20 gallons per day of silver-rich solutions and *no more than* 10,000 gallons per day of total process effluent. Medium processors should recover silver to at least 95 percent efficiency. 95%
- A **large** diagnostic or industrial X-ray film processor is one that produces *more than* 20 gallons per day of silver-rich solutions and *no more than* 25,000 gallons per day of total process effluent. Large processors should recover silver to at least 99 percent efficiency. 99%
- A **significant industrial user** (SIU) is a processor that discharges more than 25,000 gallons per day of total process effluent.* SIUs have no set percentage recovery efficiency as each SIU is individually permitted.

Through the use of this guide, diagnostic and industrial X-ray film processors, together with the local agency can cooperatively manage silver discharges to sewer. This guide offers a uniform set of

* The EPA defines a significant industrial user as a facility that discharges an average of 25,000 gallons per day or more of *process wastewater* to the publicly owned treatment works (POTW) (excluding sanitary, noncontact cooling and boiler blowdown wastewater). Individual municipalities are free to use a more stringent definition. (40 CFR 403.3 (t)(ii))

recommendations for controlling photoprocessing waste and moves away from existing restrictions that are difficult to achieve given today's technology and our efforts to conserve water.

Performance-based limits are realistic, given the technology currently available to diagnostic and industrial X-ray film processors. Performance-based limits that are uniform across the country will allow film processors to self-regulate.

Performance-based limits are the best way to ensure industrial waste is properly managed while providing economic incentives to diagnostic and industrial X-ray film processors.

1.2 Implementing the Code

Who is responsible for ensuring this silver management program is implemented? In a medium or large operation, the responsible person is most likely the film processing manager. While the technical services department, a quality assurance (QA) technician or even a radiology technologist (RT) may be assigned the job of putting certain aspects of the Code in place, the final responsibility rests with management.

That responsibility cannot be delegated.

Even if an outside contractor services the processors and silver recovery systems, the responsibility stays with the diagnostic or industrial X-ray film processing manager.

In a small facility such as a dental or veterinary office, the doctor is most likely the responsible person. While a hygienist or assistant may undertake some of the duties of silver management and pollution prevention, the final responsibility lies with the person in charge.

2.0 Determining the Category

The first step is to determine which of the four categories best describes each of your film processors: small, medium, large or significant industrial user (SIU). Remember: If you have centralized silver recovery, you should consider the number of films processed *throughout the entire facility* rather than by individual machine.

To determine your size you can monitor the volume of both fixer and total process effluent produced daily for each film processor. Then use the definitions on page 4 to find out which category best describes your situation: small, medium or large.

Since it may be easier for you to simply track the amount of film used, we've provided the chart below that translates the volume of chemicals used into the number of films processed. To use this simple chart, follow these steps:

1. Find the box in the left-hand column of the chart that best describes the type of film you process — dental, general purpose, mammography or industrial X-ray.

Size Category Based on Type and Quantity of Film Processed Daily*

Type of Film Processed	Small	Medium	Large
Dental	1 - 750	751 - 7,500	N/A
General Purpose	1 - 100	101 - 900	901 - 24,000
Mammography	1 - 250	251 - 2,500	2,501 - 24,000
Industrial X-ray	1 - 50	51 - 400	401 - 6,000

* These numbers are based on the assumptions shown in Appendix H.

2. For a specific film processor, estimate the number of films processed *per day*.
3. Move across the row to the square containing the number of films processed per day as estimated above.
4. Look at the heading in that column to identify the size category for that processing machine.
5. Now, categorize each of the remaining film processors if you have more than one.

For example, a machine processing 60 dental radiographs per day would be in the *small* category. On the other hand, a machine processing 60 industrial X-ray films per day would be considered *medium*. Note: If a machine falls at a break point between categories (e.g., 100 general purpose films), talk with your supplier to make sure that you select the correct category.

Now that you've identified the category of each of your processors, let's move on.

- For small processors, turn to Section 3.0 on page 6.
- For medium processors, turn to Section 4.0 on page 9.
- For large processors, turn to Section 5.0 on page 14.
- SIUs are beyond the scope of this guide. If you fall into this category, you should consult your POTW.

3.0 Small Processors

A small diagnostic or industrial X-ray film processor is one that produces less than 2 gallons per day of silver-rich solutions and no more than 1,000 gallons per day of total process effluent. Small processors should recover silver to at least 90 percent efficiency.

Remember: The category size of *small* is based on an individual machine *not* the whole facility. This is done to ensure the silver recovery equipment and testing recommendations are appropriate for the size and utilization of the processing equipment.

Small diagnostic and industrial X-ray film processors have three practical options for achieving a 90 percent removal. These can be configured in several ways, discussed below.

3.1 Options

The following options are recommended for recovering at least 90 percent of the silver from silver-rich solutions:

1. one or two metallic replacement cartridges (MRCs)* with manufacturer-specified flow control,[†] or

* Facilities that generate less than 0.5 gallons per day of silver-rich solutions need only one MRC. Due to the low volume, a second MRC would oxidize and channel by the time the first MRC was exhausted resulting in no additional silver recovery.

[†] Flow control may be gravity feed or a metering pump, depending upon the design capabilities of the cartridge and the processing workload. Work with your supplier to determine the flow control appropriate for your system.

2. off-site management, or
3. alternative technology providing at least 90 percent silver recovery.**

3.2 Equipment Configurations

In this section for small diagnostic and industrial X-ray film processors, we'll review typical silver recovery equipment configurations for each of the compliance options. Detailed information is available in the appendices.

We'll also describe the testing methods and procedures to use with the equipment to verify that it is recovering at least 90 percent of the silver.

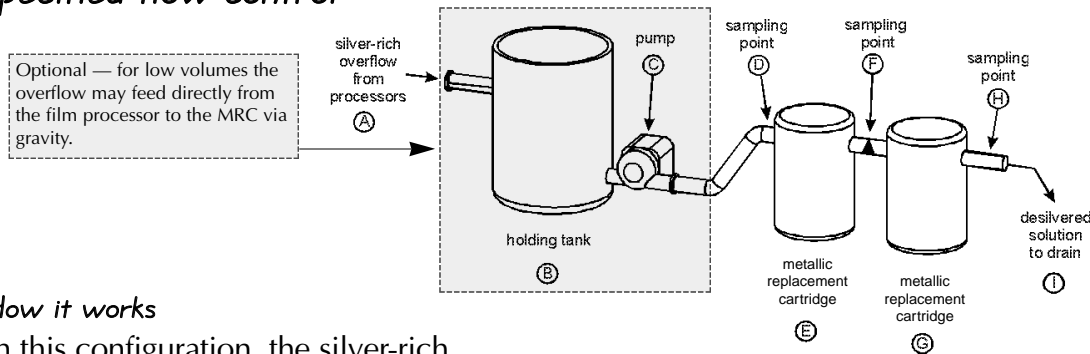
Finally, we'll show you samples of simple silver recovery logs to use for recording the results of the testing.

For detailed information about a specific silver recovery option, how it works, and preventive maintenance recommendations, refer to:

Appendix C Metallic Replacement Cartridges
Appendix D Off-Site Management

** This option allows for improvements to existing technology and for new technology, developed after this guide was written. It also allows for less commonly used technology that is available and can meet the percent recovery requirements.

1. One or two metallic replacement cartridges (MRCs) with manufacturer-specified flow control



How it works

In this configuration, the silver-rich overflow from the processor (A) is directed to a holding tank (B). Next, it is fed via gravity or a metering pump (C) at a fixed rate through the metallic replacement cartridges (MRCs) set up in series (E and G). In this diagram two MRCs are shown. Once the solution exits the last cartridge in series (H) at least 90 percent of the silver has been recovered and the solution can be discharged to the drain (I) with permission.

Testing methods

There are two types of testing methods you should use:

- **once each week**, use silver-estimating test papers or another method of approximating silver concentration to check whether the system is working (if the paper shows any change in color, the system is not working*), and
- **once every year**, use highly accurate analytical laboratory testing such as atomic absorption (AA) or inductively coupled plasma spectroscopy (ICP). Use an outside service for analytical testing.

Testing procedures

1. To indicate whether the system is working, check the solution **weekly** at

* This may vary for systems in which the MRCs are rotated rather than both replaced at the same time.

two locations using a method of approximating the silver concentration:

- after the first MRC at (F)
- after the last MRC at (H)

2. To verify the percent efficiency of the system, use an analytical laboratory to test the solution **once every year**, from two locations:

- before the first MRC at (B) or (D)
- after the last MRC at (H)

See Appendix F for more information about testing for silver.

Testing records

- Record all test results in a silver recovery log. See the examples below. Check with the publicly owned treatment works (POTW) to find out how long to keep records on file.

Silver Recovery Log		
Date	Weekly Effluent Check*	
	MRC #1	MRC #2
7/1/96	P	P
7/8/96	P	P
7/15/96	F	P

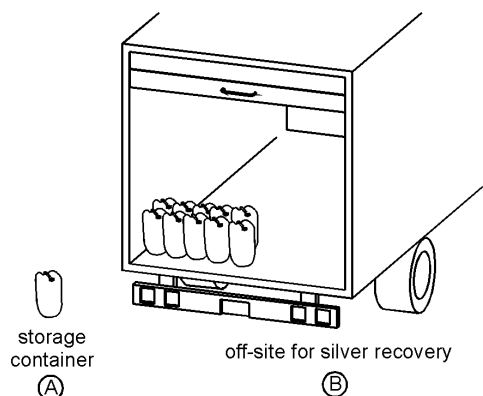
* Pass (P) = no color, Fail (F) = color

When the weekly check indicates cartridge failure, refer to the equipment manual for the manufacturer's recommendations.

Silver Recovery Log (ppm)			
Date	Annual Test		%
	Influent	Effluent	Recovery
7/1/96	2,500	150	94%*
7/1/97			
7/1/98			

* To obtain the percent recovery, use the following formula:
 $100 - (\text{effluent} \times 100 \div \text{influent})$.

2. Off-site management



How it works

In this configuration, the silver-rich solution overflow from the processor is stored in a container (A) until it is picked-up by a licensed hauler for off-site silver recovery, treatment and/or disposal (B).

Testing requirements

There are no Code of Management Practice testing requirements for verifying silver recovery efficiencies. State waste agencies, however, may require testing in order to characterize the waste.

Additional requirements

Diagnostic and industrial X-ray film processors using off-site management must meet the following requirements:

- Store the silver-rich solutions in containers that are compatible with film processing solutions.
- If it's required in your jurisdiction, provide secondary containment for storage tanks.

- Comply with all applicable hazardous waste and DOT regulations.
- Keep records of volumes and types of solutions transferred off-site. See the example log below.

Date	Amount (gallons)	Type of Solution	Manifest Number
9/9/96	44	silver - rich photo	MI 3084201
10/7/96	44	silver - rich photo	MI 3084202
11/4/96	55	silver - rich photo	MI 3084203
12/2/96	48	silver - rich photo	MI 3084204
1/6/97	55	silver - rich photo	MI 3084205

- Maintain logs, hazardous waste manifests and other records for at least three years. Make the records available for inspection by the sewage treatment authorities.
- Verify the contractor is properly licensed to transport your waste and is handling it correctly.

4.0 Medium Processors

A medium diagnostic or industrial X-ray film processor is one that produces less than 20 gallons per day of silver-rich solutions and no more than 10,000 gallons per day of total process effluent. Medium processors should recover silver to at least 95 percent efficiency.

Remember: The category size of *medium* is based on an individual machine *not* the whole facility. This is done to ensure the silver recovery equipment and testing recommendations are appropriate for the size and utilization of the processing equipment.

Medium diagnostic and industrial X-ray film processors have five practical options for achieving a 95 percent removal. These can be configured in several ways, discussed below.

4.1 Options

The following options are recommended for recovering at least 95 percent of the silver from silver-rich solutions:

1. terminal electrolytic unit followed by a metallic replacement cartridge (MRC) with manufacturer-specified flow control*, or

* Flow control may be gravity feed or a metering pump, depending upon the design capabilities of the cartridge and the processing workload. Work with your supplier to determine the flow control appropriate for your system.

2. in-line electrolytic unit with a metallic replacement cartridge (MRC) with manufacturer-specified flow control*, or
3. two or more MRCs with manufacturer-specified flow control, or
4. off-site management, or
5. alternative technology providing at least 95 percent silver recovery.**

4.2 Equipment Configurations

In this section for medium diagnostic and industrial X-ray film processors, we'll review typical silver recovery equipment configurations for each of the compliance options. Detailed information is available in the appendices.

We'll also describe the testing methods and procedures to use with the equipment to verify that it is recovering at least 95 percent of the silver.

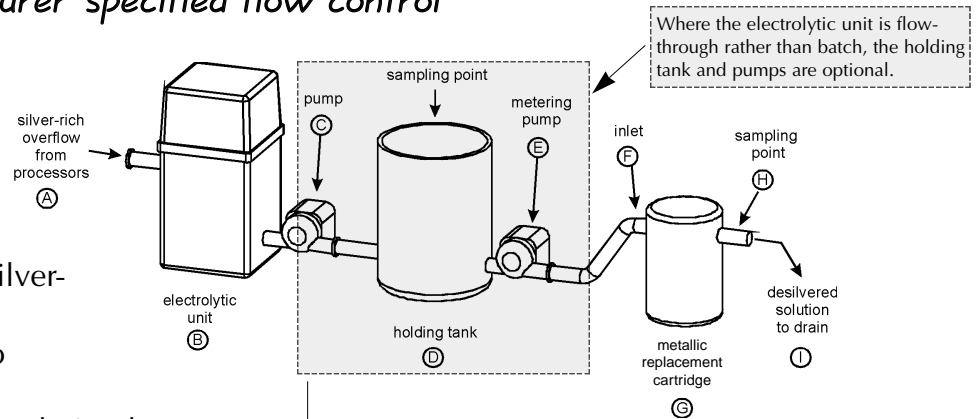
Finally, we'll show you samples of simple silver recovery logs to use for recording the results of the testing.

For detailed information about a specific silver recovery option, how it works, and preventive maintenance recommendations, refer to:

Appendix B Electrolytic Silver Recovery
Appendix C Metallic Replacement Cartridges
Appendix D Off-Site Management

** This option allows for improvements to existing technology and for new technology, developed after this guide was written. It also allows for less commonly used technology that is available and can meet the percent recovery requirements.

1. Terminal electrolytic unit followed by a metallic replacement cartridge (MRC) with manufacturer-specified flow control



How it works

In this configuration, the silver-rich overflow from the processor (A) is directed to the electrolytic unit (B).

When sufficient silver-rich solution has accumulated, the electrolytic unit begins to desilver the solution. When the batch is completed, the partially desilvered solution is pumped out (C) of the electrolytic unit into the holding tank (D). From here, it is metered (E) at a fixed rate through the metallic replacement cartridge (G). Once the solution exits the cartridge (H) at least 95 percent of the silver has been recovered and the solution can be discharged to the drain (I), with permission.

Testing methods

There are two types of testing methods you should use:

- **once each week**, use silver-estimating test papers or another method of approximating silver concentration to check whether the system is working (if the paper shows any change in color, the system is not working), and
- **once every six months**, use highly accurate analytical laboratory testing such as atomic absorption (AA) or inductively coupled plasma spectroscopy (ICP). Use an outside service for analytical testing.

Testing procedures

1. To indicate whether the system is

working, check the solution **weekly** at two locations using a method of approximating the silver concentration:

- after the electrolytic unit at (D)
- after the MRC at (H)

2. To verify the percent efficiency of the system, use an analytical laboratory to test the solution **once every six months**, from two locations:

- before the electrolytic unit at (A)
- after the MRC at (H)

See Appendix F for more information about testing for silver.

Testing records

- Record all test results in a silver recovery log. See the examples below. Check with the POTW to find out how long to keep records on file.

Silver Recovery Log		
Date	Weekly Effluent Check*	
	Electrolytic	MRC
7/1/96	P	P
7/8/96	P	P
7/15/96	P	F

* Pass (P) = no color, Fail (F) = color

When the weekly check indicates cartridge failure, refer to the equipment manual for the manufacturer's recommendations.

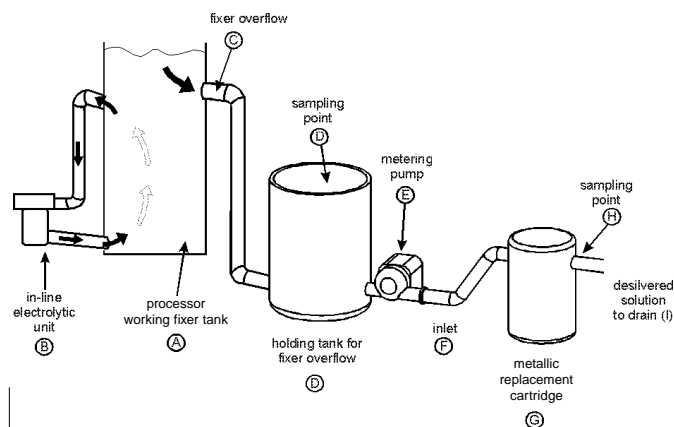
Silver Recovery Log (ppm)			
Date	Six Month Test		%
	Influent	Effluent	Recovery
7/4/96	2,500	75	97%*
1/4/97	2,530	50.6	98%*
7/4/97			

* To obtain the percent recovery, use the following formula:
 $100 - (\text{effluent} \times 100 \div \text{influent})$.

2. In-line electrolytic unit with a metallic replacement cartridge (MRC) with manufacturer-specified flow control

How it works

In this configuration, the silver-rich overflow from the processor fixer tank (A) is continuously recirculated through the in-line electrolytic silver recovery unit (B) and back into the fixer tank (A). Fixer overflow (C) is fed into the holding tank (D). From here, it is metered (E) at a fixed rate through the metallic replacement cartridge (G). Once the solution exits the cartridge (H) at least 95 percent of the silver has been recovered and the solution can be discharged to the drain (I), with permission.



test the solution **once every six months**, from one location:

- after the MRC at (H)

Note: Where an in-line unit is installed, it maintains the fixer working tank silver concentration below 1000 ppm. Since it's not possible to obtain a pre silver recovery sample, we will assume that if the in-line unit weren't there, the silver concentration in the tank would be approximately 2500 ppm.

See Appendix F for more information about testing for silver.

Testing records

- Record all test results in a silver recovery log. See the examples below. Check with the POTW to find out how long to keep records on file.

Testing methods

There are two types of testing methods you should use:

- **once each week**, use silver-estimating test papers or another method of approximating silver concentration to check whether the system is working (if the paper shows any change in color, the system is not working), and
- **once every six months**, use highly accurate analytical laboratory testing such as atomic absorption (AA) or inductively coupled plasma spectroscopy (ICP). Use an outside service for analytical testing.

Testing procedures

1. To indicate whether the system is working, check the solution **weekly** at two locations using a method of approximating the silver concentration:
 - after the electrolytic unit at (D)
 - after the MRC at (H)
2. To verify the percent efficiency of the system, use an analytical laboratory to

Date	Weekly Effluent Check*	
	Electrolytic	MRC
7/1/96	P	P
7/8/96	P	P
7/15/96	P	F

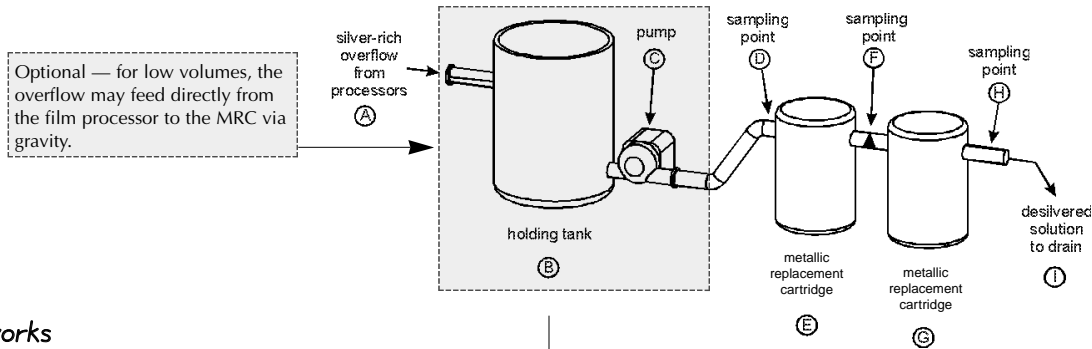
* Pass (P) = no color, Fail (F) = color

When the weekly check indicates cartridge failure, refer to the equipment manual for the manufacturer's recommendations.

Date	Six Month Test		% Recovery
	Influent	Effluent	
7/4/96	2,500	75	97%*
1/4/97	2,500	50.6	98%*
7/4/97			

* To obtain the percent recovery, use the following formula:
 $100 - (\text{effluent} \times 100 \div \text{influent})$.

3. Two or more metallic replacement cartridges (MRCs) with manufacturer-specified flow control



How it works

In this configuration, the silver-rich overflow from the processor (A) is directed to the holding tank (B). Next, it is metered (C) at a fixed rate through the metallic replacement cartridges (MRCs) set up in series (E and G). Once the solution exits the last cartridge in series (H) at least 95 percent of the silver has been recovered and the solution can be discharged to the drain (I), with permission.

Testing methods

There are two types of testing methods you should use:

- **once each week**, use silver-estimating test papers or another method of approximating silver concentration to check whether the system is working (if the paper shows any change in color, the system is not working*), and
- **once every six months**, use highly accurate analytical laboratory testing such as atomic absorption (AA) or inductively coupled plasma spectroscopy (ICP). Use an outside service for analytical testing.

Testing procedures

1. To indicate whether the system is working, check the solution **weekly** at two locations using a method of

* This may vary for systems in which the MRCs are rotated rather than both replaced at the same time.

approximating the silver concentration:

- after the first MRC at (F)
- after the second MRC at (H)

2. To verify the percent efficiency of the system, use an analytical laboratory to test the solution **once every six months**, from two locations:

- before the first MRC at (B)
- after the second MRC at (H)

See Appendix F for more information about testing for silver.

Testing records

- Record all test results in a silver recovery log. See the example below. Check with the POTW to find out how long to keep records on file.

Silver Recovery Log		
Date	Weekly Effluent Check*	
	MRC #1	MRC #2
7/1/96	P	P
7/8/96	P	P
7/15/96	F	P

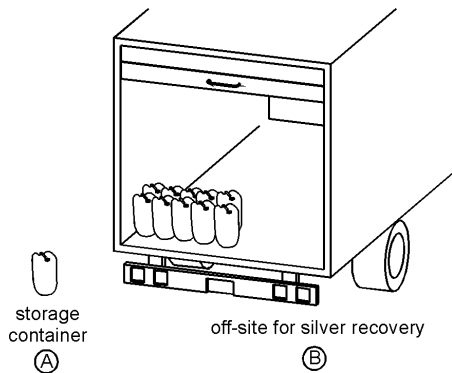
* Pass (P) = no color, Fail (F) = color

When the weekly check indicates cartridge failure, refer to the equipment manual for the manufacturer's recommendations.

Silver Recovery Log (ppm)			
Date	Six Month Test		% Recovery
	Influent	Effluent	
7/4/96	2,500	75	97%*
1/4/97	2,530	50.6	98%*
7/4/97			

* To obtain the percent recovery, use the following formula:
 $100 - (\text{effluent} \times 100 \div \text{influent})$.

4. Off-site management



How it works

In this configuration, the silver-rich solution overflow from the processor is stored in a container (A) until it is picked-up by a licensed hauler for off-site silver recovery, treatment and/or disposal (B).

Testing requirements

There are no Code of Management Practice testing requirements for verifying silver recovery efficiencies. State waste agencies, however, may require testing in order to characterize the waste.

Additional requirements

Diagnostic and industrial X-ray film processors using off-site management must meet the following requirements:

- Store the silver-rich solutions in containers that are compatible with diagnostic and industrial X-ray film processing solutions.
- If it's required in your jurisdiction, provide secondary containment for storage tanks.

- Comply with all applicable hazardous waste and DOT regulations.
- Keep records of volumes and types of solutions transferred off-site. See the example log below.

Off-Site Chemical Log			
Date	Amount (gallons)	Type of Solution	Manifest Number
9/9/96	44	silver - rich photo	MI 3084201
10/7/96	44	silver - rich photo	MI 3084202
11/4/96	55	silver - rich photo	MI 3084203
12/2/96	48	silver - rich photo	MI 3084204
1/6/97	55	silver - rich photo	MI 3084205

- Maintain logs, hazardous waste manifests and other records for at least three years. Make the records available for inspection by the sewage treatment authorities.
- Verify that the contactor is properly licensed to transport your waste and is handling it correctly.

5.0 Large Processors

A large diagnostic or industrial X-ray film processor is one that produces more than 20 gallons per day of silver-rich solutions and less than 25,000 gallons per day of total process effluent. Large processors should recover silver to at least 99 percent efficiency.

Remember: The category size of *large* is based on an individual machine *not* the whole facility. This is done to make sure the silver recovery equipment and testing recommendations are appropriate for the size and utilization of the processing equipment.

Large diagnostic and industrial X-ray film processors have several practical options for achieving a 99 percent removal. These can be configured in several ways, discussed below.

5.1 Options

The following options are recommended for recovering at least 99 percent of the silver from silver-rich solutions:

1. terminal electrolytic unit followed by two metallic replacement cartridges (MRC) with manufacturer-specified flow control, or
2. in-line electrolytic unit with two metallic replacement cartridges (MRC) with manufacturer-specified flow control, or

3. off-site management, or
4. alternative technology providing at least 99 percent silver recovery.*

5.2 Equipment Configurations

In this section for large diagnostic and industrial X-ray film processors, typical silver recovery equipment configurations for each of the compliance options. Detailed information is available in the appendices.

We'll also describe the testing methods and procedures to use with the equipment to verify that it is recovering at least 99 percent of the silver.

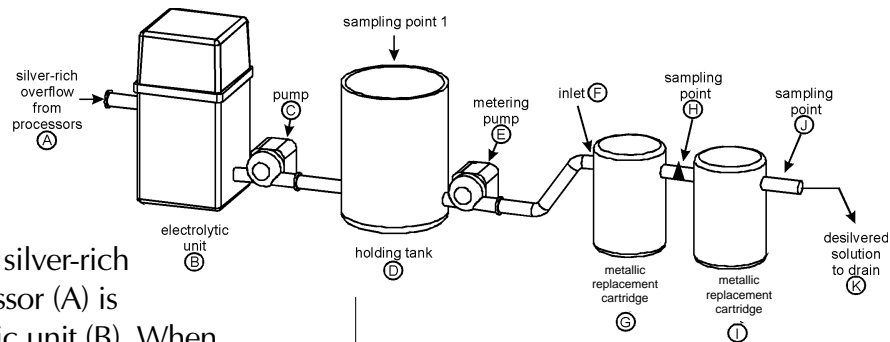
Finally, we'll show you samples of simple silver recovery logs to use for recording the results of the testing.

For detailed information about a specific silver recovery option, how it works, and preventive maintenance recommendations, refer to:

Appendix B Electrolytic Silver Recovery
 Appendix C Metallic Replacement Cartridges
 Appendix D Off-Site Management
 Appendix E Ion Exchange

* This option allows for improvements to existing technology and for new technology, developed after this guide was written. It also allows for less commonly used technology that is available and can meet the percent recovery requirements.

1. Terminal electrolytic unit followed by two or more metallic replacement cartridges (MRC) with manufacturer-specified flow control



How it works

In this configuration, the silver-rich overflow from the processor (A) is directed to the electrolytic unit (B). When sufficient silver-rich solution has accumulated, the electrolytic unit begins to desilver the solution. When the batch is completed, the partially desilvered solution is pumped out of the electrolytic unit (C) into the holding tank (D). From here, it is metered (E) at a fixed rate through the MRCs (G and I). Once the solution exits the last MRC (J) at least 99 percent of the silver has been recovered and the solution can be discharged to the drain (K), with permission.

Testing methods

There are two types of testing methods you should use:

- **once each week**, use silver-estimating test papers or another method of approximating silver concentration to check whether the system is working (if the paper shows any change in color, the system is not working), and
- **once every three months**, use highly accurate analytical laboratory testing such as atomic absorption (AA) or inductively coupled plasma spectroscopy (ICP). Use an outside service for analytical testing.

Testing procedures

1. To indicate whether the system is working, check the solution **weekly** at

two locations using a method of approximating the silver concentration:

- after the electrolytic unit at (D)
- after the first MRC at (H)
- after the last MRC at (J)

2. To verify the percent efficiency of the system, use an analytical laboratory to test the solution **once every three months**, from two locations:

- before the electrolytic unit at (A)
- after the last MRC at (J)

See Appendix F for more information about testing for silver

Testing records

- Record all test results in a silver recovery log. See the example below. Check with the POTW to find out how long to keep records on file.

Silver Recovery Log			
Date	Weekly Effluent Check*		
	Electrolytic	MRC #1	MRC #2
7/1/96	P	P	P
7/8/96	P	P	P
7/15/96	P	F	P

* Pass (P) = no color, Fail (F) = color

When the weekly check indicates cartridge failure, refer to the equipment manual for the manufacturer's recommendations.

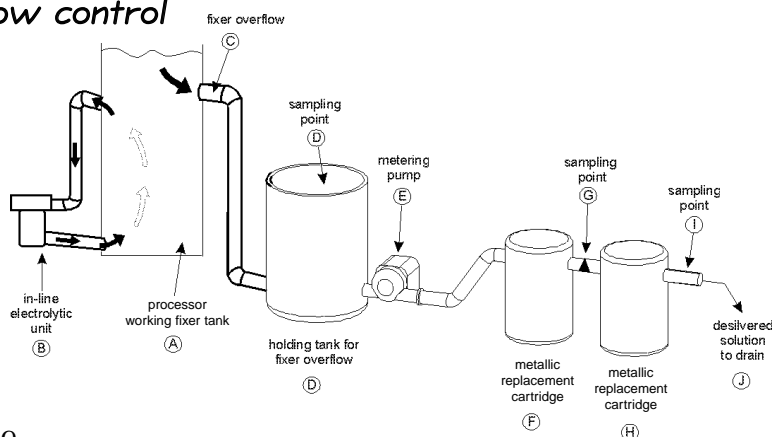
Silver Recovery Log (ppm)			
Date	Three Month Test		% Recovery
	Influent	Effluent	
7/4/96	2,500	5	99.8%*
10/4/96	2,420	2.4	99.9%*
1/4/97	2,531	2.5	99.9%*

* To obtain the percent recovery, use the following formula:
 $100 - (\text{effluent} \times 100 \div \text{influent})$.

2. In-line electrolytic unit with two metallic replacement cartridges (MRC) with manufacturer-specified flow control

How it works

In this configuration, the silver-rich overflow from the processor fixer tank (A) is continuously recirculated through the in-line electrolytic silver recovery unit (B) and back into the fixer tank (A). Fixer overflow (C) is fed into the holding tank (D). From here, it is metered (E) at a fixed rate through the metallic replacement cartridges (F and H). Once the solution exits the last cartridge (I) at least 99 percent of the silver has been recovered and the solution can be discharged to the drain (J), with permission.



2. To verify the percent efficiency of the system, use an analytical laboratory to test the solution **once every three months**, from one location:
 - after the last MRC at (I)

Note: Where an in-line unit is installed, it maintains the fixer working tank silver concentration below 1000 ppm. Since it's not possible to obtain a pre silver recovery sample, we will assume that if the in-line unit weren't there, the silver concentration in the tank would be approximately 2500 ppm.

See Appendix F for more information about testing for silver.

Testing records

- Record all test results in a silver recovery log. See the examples below. Check with the POTW to find out how long to keep records on file.

Testing methods

There are two types of testing methods you should use:

- **once each week**, use silver-estimating test papers or another method of approximating silver concentration to check whether the system is working (if the paper shows any change in color, the system is not working), and
- **once every three months**, use highly accurate analytical laboratory testing such as atomic absorption (AA) or inductively coupled plasma spectroscopy (ICP). Use an outside service for analytical testing.

Testing procedures

1. To indicate whether the system is working, check the solution **weekly** at two locations using a method of approximating the silver concentration:
 - after the electrolytic unit at (D)
 - after the first MRC at (G)
 - after the second MRC at (I)

Silver Recovery Log			
Date	Weekly Effluent Check*		
	Electrolytic	MRC #1	MRC #2
7/1/96	P	P	P
7/8/96	P	P	P
7/15/96	P	F	P

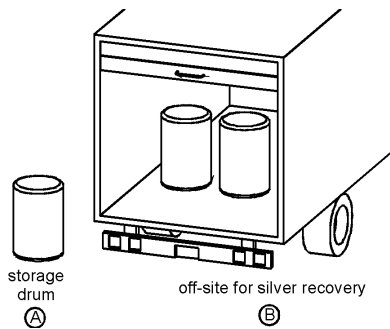
* Pass (P) = no color, Fail (F) = color

When the weekly check indicates cartridge failure, refer to the equipment manual for the manufacturer's recommendations.

Silver Recovery Log (ppm)			
Date	Three Month Test		% Recovery
	Influent	Effluent	
7/4/96	2,500	5	99.8%*
10/4/96	2,500	2.4	99.9%*
1/4/97	2,500	2.5	99.9%*

* To obtain the percent recovery, use the following formula:
 $100 - (\text{effluent} \times 100 \div \text{influent})$

3. Off-site management



How it works

In this configuration, the silver-rich solution overflow from the processor is stored in a drum (A) until it is picked-up by a licensed hauler for off-site silver recovery, treatment and/or disposal (B).

Testing requirements

There are no Code of Management Practice testing requirements for verifying silver recovery efficiencies. State waste agencies, however, may require testing in order to characterize the waste.

Additional requirements

Diagnostic and industrial X-ray film processors using off-site management must meet the following requirements:

- Store the silver-rich solutions in containers that are compatible with film processing solutions.
- If it's required in your jurisdiction, provide secondary containment for storage tanks.
- Comply with all applicable hazardous waste and DOT regulations.

- Keep records of volumes and types of solutions transferred off-site. See the example log below.

Off-Site Chemical Log			
Date	Amount (gallons)	Type of Solution	Manifest Number
9/9/96	44	silver - rich photo	MI 3084201
10/7/96	44	silver - rich photo	MI 3084202
11/4/96	55	silver - rich photo	MI 3084203
12/2/96	48	silver - rich photo	MI 3084204
1/6/97	55	silver - rich photo	MI 3084205

- Maintain logs, hazardous waste manifests and other records for at least three years. Make the records available for inspection by the sewage treatment authorities.
- Verify that the contractor is properly licensed to transport your waste and is handling it correctly.

6.0 Pollution Prevention

This section of the guide introduces several **voluntary** activities that can result in preventing pollution. We recommend that you read through it and adopt any ideas that are appropriate for your film processing operation. While many of these activities are better suited to larger operations, there are some that can also benefit even the smallest film processor.

Minimizing or reducing waste is a common practice among film processors. For example, automated processing chemical mixers are used to reduce waste caused by mixing errors. Outdated radiographs and other scrap films are sent to a recycler where the silver is recovered and the film base is recycled for use in manufacturing new film. Using good waste control practices has two benefits: it can lower the impact the operation has on the environment and it can save money through reduced materials and labor.

In today's language, waste control is called *pollution prevention*. Pollution prevention, or *P2*, is the name given to good management practices, as well as equipment and chemical modifications that result in reducing or eliminating waste. While P2 activities can be applied throughout a facility, in this guide we'll focus on the film processing area.

Most diagnostic and industrial X-ray film processors are already using some pollution prevention practices. In this section of the Code of Management Practice Guide for Diagnostic and Industrial X-Ray Film Processors we're

going to give you a method to look at your diagnostic or industrial X-ray film processing operation, identify options for voluntary pollution prevention, put a P2 plan in place and follow-up on the success of that plan. The diagram on the next page shows the five steps of P2 planning:

- 1. Create a team** of interested and capable staff and administrative employees to develop and oversee pollution prevention activities in your facility.
- 2. Review your options** by examining your current practices in light of alternative or additional measures that can reduce or eliminate waste.
- 3. Develop a P2 plan** by deciding which options you'll adopt, the time frame for adopting them, and who will be responsible for overseeing implementation and maintenance of the option.
- 4. Put the plan in place** by providing the staff with pollution prevention training and resources.
- 5. Track your results** by keeping records where they are helpful and by routinely auditing or inspecting your diagnostic or industrial X-ray film processing operation for pollution prevention opportunities.

Not every pollution prevention activity discussed in this section will make sense for you. For example, if the film processing volume is low, an in-line electrolytic system is probably not a good choice. This is just one example of why

Planning for Pollution Prevention



it's so important for you to conduct a thorough review of your operation and examine your options before you begin to develop a P2 plan.

In the following pages of this section, we provide you with specific P2 information and checklists to assess your performance.

6.1 Create a Team

Commitment from management and staff is an essential element of a successful pollution prevention plan.

Management supports the plan by 1) developing, implementing and maintaining a P2 policy, 2) forming a P2 team, and 3) allowing adequate time and resources for P2 activities.

Staff supports the plan by working with management to ensure pollution prevention is a priority in the diagnostic or industrial X-ray film processing area.

a. Management activities

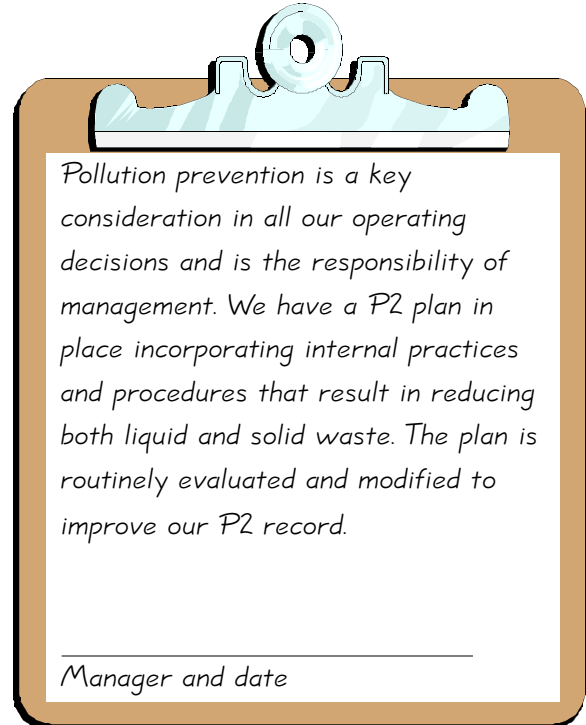
There's no substitution for good leadership in pollution prevention. Management is responsible for setting the pollution prevention policy, establishing who will

help with the plan and providing the necessary resources.

A pollution prevention policy

A pollution prevention policy is a simple and clear statement that waste reduction and elimination are goals of your facility. We've provided an example of a policy below. Make sure your policy is signed by a manager to show commitment and responsibility for P2 activities.

Once the policy is developed, post it for all employees, and perhaps even patients clients or customers to see. Remember — the success of P2 depends upon support from all the people in the film processing operation. You may decide to develop the policy with the help of the P2 team.



The P2 team

The pollution prevention team is the group of managers and staff people who develop, implement and evaluate all the activities that go into making up the P2 plan.

- *How many people should be on the team?* That depends upon the size of your operation. In a three or four person diagnostic or industrial X-ray film processing operation, it might be a team of one — the supervisor. In a large facility, it might be a team of five or six. You decide how many people you need.

- *Who makes the best team member?* The best team member is someone who's interested in pollution prevention, who wants to be on the team and who has a good understanding of film processing systems. In large facilities try to get representatives of different departments where film processing is done.

- *What about a team leader?* The P2 team needs a leader. Management can leave that decision up to the team or it can designate someone.

Time and resources for the P2 team

The P2 team needs time and resources to do its job properly. Time means time to meet, audit the facility, develop the P2 plan, put it into action, and periodically evaluate it. Resources mean training and technical information such as number of films processed and replenishment rates. Management should provide these as part of its commitment to P2.

b. Staff activities

Everyone has a part to play in pollution prevention. Some staff will be part of the P2 team. Their responsibilities will be to help develop the P2 plan and put it in place.

The rest of the staff will be trained to recognize pollution prevention opportunities and to work in such a way that doesn't create waste in the first place.

Checklist

This checklist reviews all the elements for putting together a P2 team. When you have the team in place, you should be able to answer “Yes” to all questions. “No” answers are potential pollution prevention opportunities. When you don’t have adequate information to answer, check the “?” Then get the information you need to make an assessment.

<i>Pollution Prevention Team</i>			
	Yes	No	?
• Do you have a P2 policy?			
• Has it been signed and dated by a manager?			
• Is the policy posted where all staff can see it?			
• Have staff members been told about the P2 policy and its purpose?			
• Has the P2 team been formed?			
• Are the team members knowledgeable about film processing?			
• Has a team leader been chosen?			
• Does management provide the team with the time and resources needed for P2 planning and implementation?			

6.2 Review Your Options

Pollution prevention options for film processing solutions can be placed into one of three categories:

- 1) management practices,
- 2) equipment modifications, and
- 3) process modifications.

We'll examine each of these. We'll also look at options for managing the solid waste produced in diagnostic and industrial X-ray film processing.

At this phase of the P2 process, we're only *looking* at the possible options. After each discussion, we've included a checklist for you to evaluate your practices and equipment. A "Yes" answer means you're already practicing that P2 activity. Anytime you answer "No" you've found a potential pollution prevention opportunity. Anytime you answer "?" it means you need more information to evaluate the option. When you finish, look back at the checklists and with the team, choose the best P2 options for your operation.

a. Management practices

Some of the simplest and least expensive management practices may produce the most effective pollution prevention results. Keep this in mind as we look at the following management practices.

Preventive maintenance

Preventive maintenance should be your first pollution prevention option. By implementing an effective preventive maintenance program, the film processing equipment will work at its optimum level, keeping waste at a minimum. Use the recommendations found in the equipment

operating manuals as a starting point for your preventive maintenance program. Contact the equipment manufacturer for more information.

Process control

Process control is the routine monitoring of variables that affect the quality of your product. These variables include:

- replenishment rates,
- processing temperatures
- processing times, and
- chemical mix procedures.

They should be checked routinely to ensure that film image quality is good, image stability is maximized and waste is minimized. These variables should be monitored on a schedule tied to the preventive maintenance schedule.

The film processor should also routinely run control strips, chart the results of each strip (see the control chart on the next page) and take action based on the results.

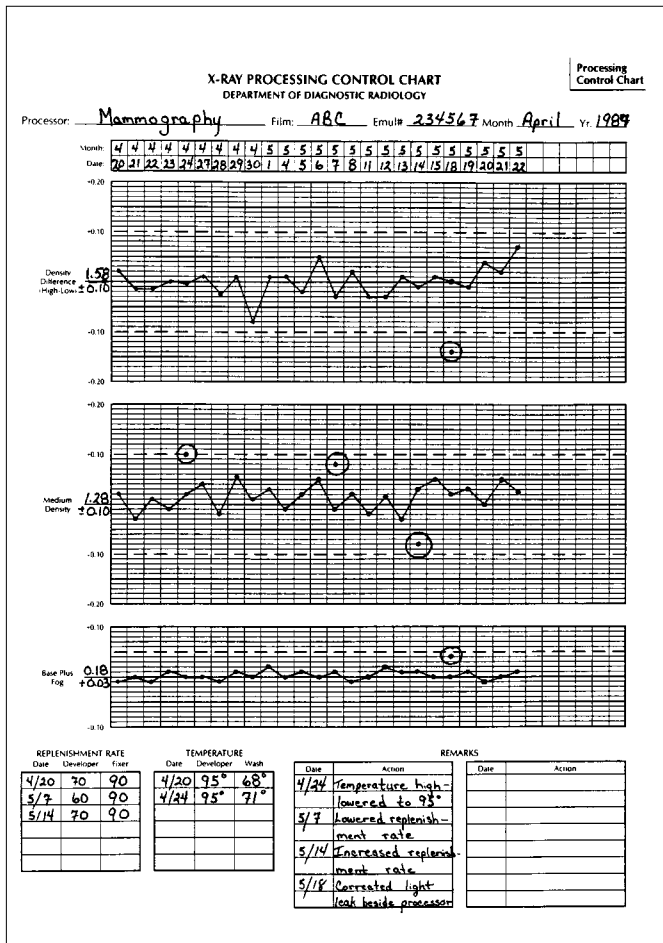
Inventory control

Managing the chemical inventory includes rotating the stock so that the oldest is used first and maintaining an appropriate supply of chemicals on-hand. This reduces the amount of money tied-up in overstock or having to dispose of old, unused chemicals.

Spill response planning

Any time a solution is unintentionally released it's a spill. The key word is **unintentional**. When you produce a waste solution during processor cleaning and recharging, it's intentional. But if a container of film processing solution is dropped on the floor, ruptures and leaks, you have an unintentional spill.

Example process control chart



Most spills are minor splashes or leaks and can be cleaned up with a sponge or mop. Occasionally, however, a larger spill could occur requiring specialized clean-up materials and procedures.

The time to plan for a spill is long before it happens. A good spill response plan will help minimize the effects of the spill on the environment and ensure the diagnostic or industrial X-ray film processor returns to normal as quickly as possible. Some of the items to include in your spill response plan include:

- an inventory of all the chemicals used in the diagnostic or industrial imaging film processing operation,

- a floor plan showing the location of all chemicals in the film processing area, floor drains, exits, fire extinguishers and spill response supplies,
- a description of the containment used for silver recovery equipment, chemical mixers and storage tanks and any other containers that could leak or rupture,
- a list of spill response supplies and equipment such as mop, pail, sponge, co-polymer or other absorbent materials and personal protective equipment, and
- a set of tested procedures for responding to a spill. A sample spill response procedure, as shown below, is included in Appendix G.

Film Processor Inc.*

SPILL CONTINGENCY PLAN

Spill Response Personnel

Name	pager/phone
Name	pager/phone
Name	pager/phone

**Environmental
Emergency
Phone**

(999) 999-9999

24 hours a day
7 days a week

EQUIPMENT REQUIRED

<ul style="list-style-type: none"> Gloves Apron Goggles 	<ul style="list-style-type: none"> Bucket Mop Sponge 	<ul style="list-style-type: none"> Absorbent Materials
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SPILL RESPONSE PROCEDURES

- Put on gloves, goggles and an apron.
- Contain the spill with a mop or absorbent materials available.
- Check the appropriate material safety data sheet (MSDS) for special handling, ventilation, personal protection or other pertinent data.
- Clean up the spill, as directed, using generous amounts of water.
- Use the mop and sponge to clean the area thoroughly.
- Package and label all contaminated absorbent materials for off-site disposal.
- Notify the supervisor or manager that a spill has occurred.
- (If required) Notify the appropriate government agency that a spill has occurred.

* This plan will not meet the requirements in all states, including California.

Good housekeeping

In a clean and orderly facility, there's better control over materials and equipment and less likelihood of spills. This results in less operational waste and prevents pollution.

Good housekeeping is one of those inexpensive and simple management practices that can significantly reduce waste, increase productivity and lower costs. You can't afford to neglect it. Here are three basic good housekeeping guidelines:

1. Designate an appropriate storage area for all materials and equipment.
2. Require every employee to return all materials and equipment to their designated area.
3. Establish a procedure and a schedule to inspect chemical receiving, storage, mixing, and use areas for spills, leaks, cleanliness and orderliness.

Safety and security

Keeping chemical areas safe and secure can minimize spills and other upsets.

- Make sure there is always someone trained in spill response procedures in the facility or who can be contacted to respond immediately.
- Restrict staff admittance to areas where chemicals are used and stored to those who have had hazard communication training.
- Make sure there's an MSDS on file for every chemical in the facility.
- Maintain a security system so that you know when someone is in the facility, both during and after working hours.

Checklist

This checklist reviews all the elements for evaluating management practices. “Yes” answers indicate that you’re already using that pollution prevention measure. “No” answers are potential pollution prevention opportunities. When you don’t have adequate information to answer, check the “?” Then get the information you need to make an assessment. Mark “N/A” (not applicable) when the item doesn’t apply in your situation.

<i>Management Practices</i>				
<i>Preventive Maintenance</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Is there a preventive maintenance program in place incorporating all the equipment manufacturer recommendations? 				
<i>Process Control</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Are solution replenishment rates routinely monitored? 				
<ul style="list-style-type: none"> Are processing tank temperatures routinely checked? 				
<ul style="list-style-type: none"> Are the appropriate staff trained in correct chemical mix procedures? 				
<ul style="list-style-type: none"> Are control strips run on processors at least once per day? 				
<ul style="list-style-type: none"> Are all control strips plotted on control charts? 				
<ul style="list-style-type: none"> When corrective action is taken, is it noted on the control chart? 				
<i>Inventory Control</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Is the oldest chemical stock always used first? 				
<ul style="list-style-type: none"> Are appropriate levels of stock maintained? 				
<i>Spill Response Planning</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Is there a spill response plan? 				
<ul style="list-style-type: none"> Is there an inventory of all chemicals in the film processing area? 				
<ul style="list-style-type: none"> Is there a floor plan detailing the location of chemicals, floor drains, exits, fire extinguishers and spill response supplies? 				
<ul style="list-style-type: none"> Is there containment around all permanent chemical containers? 				
<ul style="list-style-type: none"> Are the spill response supplies easily accessible? 				
<ul style="list-style-type: none"> Are spill response personnel properly trained? 				

<i>Management Practices (continued)</i>				
<i>Good housekeeping</i>	Yes	No	?	N/A
• Are all materials and equipment kept in a specified location?				
• Are all chemical containers routinely checked for cracks or leaks?				
• Is all equipment wiped clean of chemical residue and dirt?				
• Are all floors free of chemical spills and residue?				
• Are aisles and walkways clear?				
• Does the film processing area look orderly and clean?				
• Are all employees held accountable for good housekeeping?				
<i>Safety and Security</i>	Yes	No	?	N/A
• Is there at least one staff member trained in spill response in the facility or available at all times?				
• Are areas where chemicals are used and stored restricted to staff trained in safe chemical handling (hazard communication)?				
• Where it's required, is there an MSDS for every chemical?				
• Is there a security system in place during both working and nonworking hours?				

b. Equipment modifications

A second category of pollution prevention options is equipment modifications. This refers to the changes made to film processors to reduce the amount of waste solution produced through processing. As we examine each of these options remember what we said earlier:

Not every one of these options is appropriate for your equipment. In some cases, equipment cannot be modified. Check with your equipment manufacturer.

Crossovers/squeegees

Crossovers/squeegees are an effective P2 option that improves silver recovery. As the film exits the fixer tank, it carries over a certain amount of silver-rich solution into the wash. Crossovers/squeegees reduce carryover, therefore keeping the silver in the fixer tank where the overflow can be sent to silver recovery instead of being lost in the wash tanks.* Care and routine maintenance can extend the life and effectiveness of crossovers/squeegees.

In-line silver recovery

Another way to reduce the silver carried over from the fixer tank into the wash tanks is to reduce the concentration of silver in the fixer. This can be done with in-line silver recovery (sometimes called recirculating or closed-loop silver recovery).

In-line silver recovery is an electrolytic unit through which the fixer in the processor tank is recirculated and constantly desilvered. By keeping the silver concentration in the fixer tank at a lower level, the amount of silver lost to

the wash is significantly reduced.

There are other benefits of in-line silver recovery. Generally, it's possible to use a lower fixer replenishment rate which means lower chemical consumption. Additionally, the silver recovered is high grade silver flake.

If you use in-line silver recovery, check with your chemical supplier to determine if you need a specially formulated fixer.

Standby water saver

Today, most processors come equipped with an extremely efficient water saving device called standby water saver. This controls the wash water so it runs *only* when film is being processed. When the film clears the machine, the wash goes into standby position and doesn't begin again until the next film is processed. This equipment modification can save hundreds of gallons of water. If you have an older machine, check with your supplier to find out if it's possible to have it modified for a standby water saver.

* Crossovers/squeegees are also used between the developer and fixer tanks. This minimizes developer carryover that can contaminate the fixer.

Checklist

This checklist reviews all the elements for evaluating equipment modifications. “Yes” answers indicate that you’re already using that pollution prevention measure. “No” answers are potential pollution prevention opportunities. When you don’t have adequate information to answer, check the “?” Then get the information you need to make an assessment. Mark “N/A” (not applicable) when the item doesn’t apply in your situation.

<i>Equipment modifications</i>				
<i>Crossovers/Squeegees</i>	Yes	No	?	N/A
• Are there crossovers/squeegees on processors capable of being equipped?				
• Are all crossovers/squeegees routinely checked, cleaned and replaced as necessary?				
• Are all crossovers/squeegees cleaned as part of the shut-down procedure?				
<i>In-line Silver Recovery (if applicable)</i>	Yes	No	?	N/A
• Is there an in-line electrolytic unit on all film fixer tanks?				
• Is the silver concentration in the tank monitored so that it doesn’t get below 500 ppm or above 1000 ppm?				
• Is the fixer appropriate for in-line silver recovery?				
• Has the fixer replenishment rate been reduced?				
<i>Standby Wash (if applicable)</i>	Yes	No	?	N/A
• Are the processors equipped with standby wash?				

c. Process modifications

The third category of pollution prevention options is process modifications. Just as with equipment modifications, not all processors can be changed to accommodate every one of these process modifications.

Solution regeneration and reuse

Regenerating and reusing processing solutions may reduce the amount of chemicals to be desilvered or discharged to the drain. If the equipment can be modified and the film use is high enough, these pollution prevention options can significantly reduce waste. **Talk with your film and chemical suppliers to find out if this option is appropriate for your facility.**

Off-site chemical recycling may also be an option. In this case, the film processing facility collects the fixer overflow at the processor and periodically ships the collected solution to the recycler. From here, the fixer is desilvered and also regenerated for reuse. The regenerated fixer is then returned to the film processing facility to be used as fresh chemical for processing radiographs.

Water recirculation and recycling

Water is a valuable resource and should be conserved. Under certain conditions, wash water recirculators can be used to reduce the volume of water required for processing and reduce heat requirements for maintaining wash water temperatures. Another alternative is the standby wash discussed on page 27.

Because wash water has a direct affect on image stability, always consult with your manufacturer before making water conservation modifications to the processors.

Dry chemicals and automated mixing

Under some conditions, dry chemical packaging and automated mixing can contribute to waste minimization through extended shelf life and less packaging material.

Checklist

This checklist reviews all the elements for evaluating process modifications. “Yes” answers indicate that you’re already using that pollution prevention measure. “No” answers are potential pollution prevention opportunities. When you don’t have adequate information to answer, check the “?” Then get the information you need to make an assessment. Mark “N/A” (not applicable) when the item doesn’t apply in your situation.

<i>Process modifications</i>				
<i>Replenishment</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Have replenishment rates been measured or adjusted to manufacturer specifications? 				
<ul style="list-style-type: none"> Are there opportunities to lower fixer replenishment rates? 				
<i>Solution Reuse</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Is fixer regenerated where it’s practical? 				
<ul style="list-style-type: none"> Is the portion of the silver-rich fixer that is not regenerated sent for silver recovery? 				
<ul style="list-style-type: none"> Are chemicals reused where it’s practical? (e.g., developer or fixer recirculators) 				
<i>Water Reuse and Recycling</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Are wash water rates set at manufacturer recommendations? 				
<ul style="list-style-type: none"> Does the wash water run only during processing? 				
<ul style="list-style-type: none"> Is wash water conservation being used? (e.g., wash water recirculator or standby wash) 				
<i>Other Process Modifications</i>	Yes	No	?	N/A
<ul style="list-style-type: none"> Are dry chemicals used where it’s practical? 				
<ul style="list-style-type: none"> Are automated mixers used where it’s practical? 				

d. Solid waste

There are pollution prevention opportunities for reducing the solid waste produced in diagnostic and industrial X-ray film processing. For example, film can be sent out for polyester plastic processing and silver refining. Local recyclers will accept cardboard from film boxes, the outer cardboard from chemical containers and they may also accept thoroughly rinsed plastic liners.

Many cities have recycling programs for most of the solid waste generated in your film processing area. Reusing and recycling reduces the amount of solid waste going to landfill and lowers your waste disposal fees.



Checklist

This checklist reviews all the elements for evaluating your solid waste management program. "Yes" answers indicate that you're already using that pollution prevention measure. "No" answers are potential pollution prevention opportunities. When you don't have adequate information to answer, check the "?" Then get the information you need to make an assessment. Mark "N/A" (not applicable) when the item doesn't apply in your situation.

Solid Waste				
Are the following solid wastes reused:	Yes	No	?	N/A
• Plastic film bags?				
• Cardboard film boxes?				
• Packing materials including pallets and plastic wrap?				
Are the following solid wastes recycled:	Yes	No	?	N/A
• Film?				
• Unwanted or excess exposed and processed film?				
• Lead sheets?				
• Plastic chemical bottles and box liners?				
• Plastic chemical box liners?				
• Corrugated cardboard?				
• Office paper?				
• Box board?				
• Packing materials including pallets and plastic wrap?				

6.3 Develop a P2 Plan

Now that the P2 team has finished the audit or review, it's time for them to look at all the options and prioritize them as:

- **High priority** — needs immediate action
- **Medium priority** — needs action within 3 to 12 months
- **Low priority** — needs consideration within the next 1 to 2 years

Screening your options

Screen each option by asking the following questions and writing out your answers:

1. What is the potential for reducing waste and providing other environmental benefits?
2. What is it going to cost in time and materials?
3. How much money will it save in time and materials?
4. How difficult is it to implement?
5. Does it have an adverse affect on image quality?

Review the example below for screening the option of using in-line silver recovery on the film processor. A blank worksheet is included in Appendix G. Make copies as you need them and leave the original in this guide.

Worksheet for Screening Options

Date 10/2/96

Option: (example) Installing and maintaining an in-line silver recovery unit on the processor

1. **What is the potential for reducing waste and providing other environmental benefits?**
Less silver will be lost to the wash tank and therefore the drain. In addition, we may be able to reduce replenishment rates.
2. **What is it going to cost in time and materials?**
Cost of the electrolytic unit, labor for installation and periodic replacement, and labor for maintenance. (Note: estimate actual costs as closely as possible.)
3. **How much money will it save in time and materials?**
The savings will come in the increased amount of silver recovered (Note: estimate actual savings as closely as possible) and lower fixer replenishment rates.
4. **How difficult is it to implement?**
Not difficult. We can schedule the installment during the next preventive maintenance check on the machine. We need to buy the electrolytic unit. We also need to train process operators to keep the silver concentration about 500 ppm to reduce the potential for sulfiding.
5. **Could it have an adverse affect on image quality?**
No, providing it's properly set-up and maintained.

Screening all the options you've identified will take time but it's time well spent. It's very important that you actually write out your answers. Doing your homework here makes the difference between a P2 plan that exists only in your head vs. one that is implemented and working.

Point system

You might find it useful to develop a point system for rating all the options. For example, you could assign a *plus* value to every potential benefit and a *minus* value to every negative impact.

Writing the P2 plan

Whatever system you use, you need to prioritize all of the options. Now you can begin to draft the P2 plan. For your first attempt at systematic pollution prevention, we recommend that you start with only the **high priority** options. Work at getting these into place and evaluate your success

before addressing the medium and low priority options. Don't make too many changes as once — start with only three or four items.

Keep your P2 plan simple. Here is the information you should include:

- **Spell out each option and its purpose**
- **State a specific date when the option will be implemented**
- **List who is responsible**
- **Note if a record will be kept**

Review the example below. A blank Pollution Prevention Plan Worksheet is included in Appendix G. Make copies as you need them and leave the originals in this guide.

Pollution Prevention Plan Worksheet

Date 11/10/96

Option or activity: (example) Install the in-line unit on the film processor in order to reduce the amount of silver in the wash water.

Implementation date: The unit will be installed during the December preventive maintenance check.

Responsibility: Joe Smith, maintenance supervisor, will arrange to buy the unit, ensure it is installed and be responsible for seeing it is maintained. He will also train the process operators how to maintain the unit and harvest the silver.

Record: In-line electrolytic maintenance will be added to the preventive maintenance checklist.

6.4 Put the Plan in Place

Now that you have a P2 plan it's time to put it into action. These are the steps:

1. Make the plan known - Post it, explain its purpose and details to the staff, and talk it up. Through both your words and actions, make all employees aware of how committed the management is to pollution prevention. Keep employees updated on both the successes and failures of the plan.
2. Provide training and education - Make sure that anyone who is given responsibility in the P2 plan has the training and knowledge to carry out his/her tasks.
3. Provide the necessary resources - Make sure that anyone who is given responsibility in the P2 plan has the time and materials required to fully implement the P2 plan.

6.5 Track Your Results

Your P2 plan isn't a "Now I've done it so I can forget about it" kind of thing. You need to periodically review it, evaluate

which elements are working, which need to be modified and which need to be discontinued. A review every six months should be often enough.

As you evaluate your P2 plan, keep in mind your original intent for pollution prevention: minimizing or eliminating waste for both environmental and economic benefit.

Answer each of the following questions for each pollution prevention option or activity listed in your plan:

- **How much waste has been reduced or eliminated as a result of this activity?**
- **How much has it cost?**
- **How much money has it saved?**

In some cases, it may be hard to get exact answers to these questions. But try. It's important that you fully evaluate every P2 option implemented in your diagnostic or industrial X-ray film processing operation. Once again, let's look at installing an in-line unit as an example.

Worksheet for Evaluating P2

Date 5/17/96

Option: (example) Installing and maintaining an in-line electrolytic silver recovery unit on the film processor

1. Waste reduction results

Using colorimetric testing, we found the concentration of silver in the wash tank went from 95 ppm to 28 ppm. Over the 6 month period, we estimate this is 386 troy ounces of silver.

2. Costs

Materials: unit = \$1,240. Labor: installation 1-1/2 hours x \$20/hour = \$30. Daily maintenance: 1 minute at \$12/hour = \$.20 daily or \$24 for 6 months. Total costs = \$1,294.

3. Savings

386 troy oz. of silver at \$5.40 tr. oz. = \$2,084. This was the amount of silver diverted from the wash. Total savings realized were \$2,084 - \$1,294 = \$790.00 in six months.

A *successful* P2 option or activity is one that reduces waste and saves more money than it costs. Consider whether changing it would make it even more successful or whether to let it continue as is.

An *unsuccessful* option or activity is one that doesn't reduce waste, or it costs more money than it saves. With an unsuccessful option, consider whether changing it would make it successful or whether to discontinue using it.

Once you've done this evaluation for every option, you can also consider whether it's time to put some of those **medium priority** options in place. Remember not to make too many changes at once.

Spread the word

Every time you evaluate the success of the P2 plan, let the staff know the results — both the positive and the not so positive. When you decide to make changes or implement new P2 activities, remember to train the staff if there are any new procedures.

Include your P2 success stories in your facility's annual report or newsletter. If there's no environmental section in the report, now is a good time to start one.

With pollution prevention, everyone's a winner: the impact of your business on the environment is reduced and the cost savings from lower waste means more money in your pocket.

P2